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TIME SUBMITTED	25-SEP-2019 09:37AM (UTC+0700)	CHARACTER COUNT	10180
SUBMISSION ID	1179502110		

## Type of Gold Hydrothermal Deposits on Metamorphic Rock District Buru, Province Maluku

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### ABSTRACT

An investigation on gold occurrence in Buru island is needed to determine type of deposit in the area. This study aims to analyse mineralisation, alteration and metamorphic facies of metamorphic-hosted gold deposit in Buru area by using petrographic method, x-ray fluorescence, x-ray diffraction, and polish section. The results reveal that there are two types of metamorphic rocks: schists and phyllite. Greenschist facies are characterized by muscovite mineral, quartz, chlorite, biotite, clay mineral, and cordierite. Phyllite is in the same genetic condition with schist (medium metamorphism), with formation temperature ranges from 300°C to 450°C with a pressure around 1-8 Kbar through a regional metamorphism process. Alteration in quartz veins indicated the nature of proximal zone to ore zone. Silicic alteration (quartz) is also found intensely, and it is generally associated by propylitic alteration (chlorite) and sericitic (muscovite). Mineralisation follows the direction of the distribution of quartz veins with crustiform banding texture. The quartz vein thickness is from 40 cm to 50 cm. The alteration and mineralisation occurrence of the studied area suggests epithermal gold deposits type.

*Keywords: Buru island, metamorphic rocks, gold deposit, epithermal.*

Article history: Received 10 May 2016, last received in revised 20 May 2016.

### 1. INTRODUCTION

Buru Island is characterized by the occurrence of terrane consists of low grade metamorphics of greenschist facies to medium grade metamorphics of amphibolite facies. Their ages are Paleozoic and consist of micaschist, phyllite, slate, metasandstone and marble. Their composition seems to reflect an origin as flysch type sediments (Fig 1.). Further, the terrane consists of flysch type Triassic sediments (Dalan Formation) and dolomite reef limestones (Ghegan Formation).

<sup>1</sup>The terrane is overlain by Jurassic-Eocene deep-sea deposits consisting of calcilutite, shale and marl and Oligocene-Pliocene shallow-sea deposits. At the base, conglomerate and basic pillow lava are found [1].

It has been reported that the metamorphic terrane hosted some gold mineralization [2, 3, 4] indicated by segmented, sigmoidal and <sup>4</sup>discontinuous quartz veins which in line to <sup>4</sup>foliation of metamorphic host rock, especially mica schist. The quartz veins with gold generally show colloform banded,

Fig 1. Metamorphic facies classification [5].

3 sulphide banding, brecciated and bladed-like texture. Orientation trend of alteration distribution in hydrothermal deposit in Buru Island [6]. There are some genetic differences of mineralization in volcanic, metamorf, metasedimentary and limestone.

One of the places in which gold deposit found is Gunung Botak. Study on gold occurrences in this place has been conducted by several workers, but detail analyses on deposit type in metamorphic rocks especially schist has never been done. This study reports the hydrothermal deposit type on metamorphic rocks, particularly schist in Buru Island based on detail description on texture, alteration and ore mineralization style.

## 2. MATERIALS AND METHODS.

Petrographic analyses was conducted to determine rock type, texture and mineral

composition of host rocks using polarizing microscope. XRD (*X-ray Diffractions*) analyses was used to determine altered mineral while XRF (*X-Ray Fluoresence*) analyses was used to determine major elements of host rock. Gold content was analysed by *atomic absorption spectrometry* (AAS).

## 3. RESULTS AND DISCUSSION

### A. Lithology

Lithology of studied area consists of two metamorphic rocks: muscovite schist and phyllite. Muscovite schist shows light grey in color indicating chlorite alteration. Quartz vein banding generally cut the foliation but sometime in line with foliation (N20°E) and dip 16° south-southeast. Optically, muscovite schist was characterized by schistose. Mineral composition composed of muscovite (25%-

35%), quartz (15%-25%), chlorite (5%), biotite (10%) small amount of clay, cordierite and opaque mineral.

Phyllite showing foliated texture, consists of quartz, biotite and clay mineral, dark grey to blackish, sometimes greenish indicating chloritization alteration. Phyllite in Gunung Botak occur as host rock, containing quartz vein pararel to foliation (N185°E/37°).

### ***B. Hydrothermal alteration and mineralization***

Mineralization process in Gunung Botak is characterized by vein quartz, showing white –brownish to reddish due to oxidation,

(Fig. 2). Hematite ( $\text{Fe}_2\text{O}_3$ ) showing grey metallic, anisotropic, present to fill fracture in rocks. Pyrite ( $\text{FeS}_2$ ) showing pale yellow with high relief and relatively fined-grained occur as filling rock fracture associated with gold (Au). Stockwork and gangue mineral occurs in the studied area (Fig. 3).

### ***C. Rock geochemistry***

Vein quartz samples were collected from studied area and analyzed by XRF to determine major oxide while trace element were analyzed by ICP-OES and gold determination (Au) was analyzed by AAS (fire assay) method. Results

Figure 2. Microphotograph of pyrite (G4), and chalcopyrite (H6).

contain fine-grained pyrite ( $\text{FeS}_2$ ) associated with silica mineral. Other ore mineral are hematite ( $\text{Fe}_2\text{O}_3$ ), pyrite ( $\text{FeS}_2$ ) and gold (Au)

of analyses are depicted in Table 1. Correlation of Ag and Pb is shown in Fig. 4.

### D. Gold Hydrothermal Deposits

Based on field and petrographic data, the occurrence of muscovite, quartz, chlorite, biotite, clay mineral, cordierite suggest greenschist facies. Temperature ranges from 250-450°C and pressure ranges from 1-8 Kbar formed by regional metamorphism. Study result show proximal zonation to ore zone, indicated by intensive silicic alteration associated with prophyllitic (chlorite) and sericitic (muscovite). XRD result from two samples (GB 05 and GB 07) show quartz dominated indicating silicic alteration dominated by clay mineral and abundant distribution of opaque minerals. This suggests that temperature difference causes overprint between argillic (supported by clay minerals) and silicic alteration.

Generally, mineralization occurs in

Vein quartz thickness range from 3 to 10 cm which consists of interlayering between non-sulphide vein quartz banding and sulphide mineralization. On the other site of shaft, irregular cross cutting veinlets occur forming stockwork. Mineralization zone is surrounded by propylitic alteration (green in color), argillic and sericite (clay mineral, grey to greenish) and silicic. The occurrence of fluid inclusion and silicate mineral can be taken as an indication a quartz vein Au-Cu ore deposit mineralization system. Geochemical data showed that Au content from 7 analysed samples range from 0.23 to 5.9 ppm (gr/ton).

Significant gold content found in sample GB.09 (1.83 ppm). However, gold content show a negative correlation silver (Ag) content and base metal (Cu,Pb and Zn). Ag and base metal content are very low and most of

Fig. 3. Stockwork vein and gangue mineralization

quartz vein outcrop. Vein quartz shows crustiform banding with thickness from 40-50 cm.

them are below detection limit based on XRF (less than 1 ppm). As and Sb content in analyses samples generally show a significant

value (228 ppm and 33 ppm, respectively). This suggests that mineralization in the studied area is non-polymetallic mineralization or gold mineralization without silver and base metal mineralization [7].

Based on these, it was concluded that mineralization in the studied area can be concluded as hydrothermal deposit. Mineralization is hosted by greenschist-facies metamorphic rock. Alteration mineral associated with this mineralization is chlorite formed within temperature range of 200-300°C [8]. Ore mineralization in quartz found in the form of vein, indicating epithermal-hydrothermal type deposit [9].

Ag content. Similar trend is also shown by correlation diagram of Au and base metal. However, Au and Cu showed somewhat positive correlation trend. Based on trace element and associated metal shown by geochemical data, it can be assumed that mineralization in the studied area is epithermal high sulphidation [8].

#### 4. CONCLUSIONS

Based on this study, it is concluded that alteration in quartz vein Din schist showed proximal zonation to the ore. Silicic alteration was also found intensively associated with

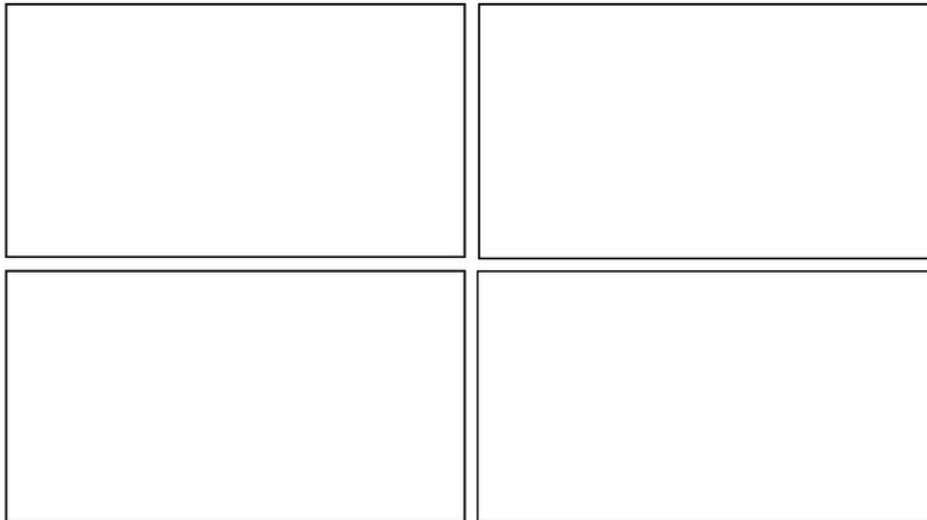


Fig. 4. Plot of Au, Ag and Ag, Pb elements.

Geochemical plot show negative correlation trend of Au and Ag, represented by stable value of Ag (0.1) with increasing of Au and stable Au content (0.23) with increasing

propilitic alteration (chlorite) and sericite alteration (muscovite). The mineralization in metamorphic rocks in line with quartz vein with crustiform banding texture distribution trend,

showing a thickness of 40 to 50 cm. Alteration and mineralization type indicated that gold deposit occur as epithermal gold deposit.

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Table 1. Geochemical result (XRF, AAS, ICP-OES)

No. Stasiun	ST.04	ST.06	ST.08	ST.09	ST.10	ST.11	ST.11	
No. Sampel	GB.04	GB.06	GB.08	GB.09	GB.10	GB.11.A	GB.11.B	DL
Tipe sampel	Float qz	Vein qz	Vein	Vein	Vein	Vein	Ore vein	
<i>Major oxides (wt.%)</i>								
SiO <sub>2</sub>	97,43	96,71	82,84	79,66	82,72	74,15	NA	0,01
TiO <sub>2</sub>	<0,01	0,02	0,49	0,47	0,42	0,75	NA	0,01
Al <sub>2</sub> O <sub>3</sub>	0,04	0,24	10,49	11,62	9,49	15,72	NA	0,01
Fe <sub>2</sub> O <sub>3</sub>	2,61	2,65	1,43	2,37	1,87	1,74	NA	0,01
MnO	0,026	0,021	0,010	0,005	0,006	0,005	NA	0,005
MgO	<0,01	<0,01	0,15	0,22	0,27	0,27	NA	0,01
CaO	0,02	<0,01	0,01	<0,01	0,02	0,01	NA	0,01
Na <sub>2</sub> O	<0,01	<0,01	0,06	0,1	0,08	0,16	NA	0,01
K <sub>2</sub> O	0,01	0,03	0,94	1,52	1,64	2,32	NA	0,01
P <sub>2</sub> O <sub>5</sub>	0,01	0,01	0,014	0,012	0,015	0,018	NA	0,001
Cr <sub>2</sub> O <sub>3</sub>	<0,05	<0,05	0,036	0,044	0,028	0,011	NA	0,005
LOI	-0,7	-0,6	3,4	3,4	2,8	4,2	NA	0,1
S	<0,002	<0,002	0,006	<0,002	<0,002	0,003	NA	0,002
<i>Trace elements (ppm)</i>								
Au	<0,01	0,31	0,23	1,83	0,85	0,76	5,9	0,01
Ag	<0,1	0,2	<0,1	0,1	<0,1	<0,1	NA	0,1
Al	0,02	0,04	1,19	1,25	0,56	1,02	NA	0,01
As	<2	51	92	228	191	153	NA	2
Ba	1	2	21	36	29	38	NA	1
Bi	<2	<2	<2	<2	<2	<2	NA	2
Ca	0,01	<0,01	<0,01	<0,01	<0,01	<0,01	NA	0,01
Cd	<0,2	<0,2	<0,2	<0,2	<0,2	<0,2	NA	0,2
Co	2	2	1	2	1	1	NA	1
Cr	18	16	15	15	7	11	NA	1
Cu	2	2	13	35	16	18	NA	1
Fe	1,79	1,87	0,83	1,66	1,3	1,02	NA	0,01
Ga	2	2	3	4	3	4	NA	2
K	<0,01	0,01	0,1	0,2	0,15	0,22	NA	0,01
La	<1	<1	4	4	10	21	NA	1
Li	<1	<1	1	2	1	1	NA	1
Mg	0,01	<0,01	0,01	0,02	0,01	0,02	NA	0,01
Mn	182	159	16	22	8	10	NA	1
Mo	1	<1	<1	1	<1	1	NA	1
Na	0,01	<0,01	0,01	0,01	0,01	0,01	NA	0,01
Nb	<1	<1	<1	<1	<1	<1	NA	1
Ni	4	3	1	1	<1	<1	NA	1
Pb	<2	<2	2	3	4	6	NA	2
Sb	1	9	20	26	33	26	NA	1
Sc	<1	<1	3	3	2	5	NA	1
Se	<10	<10	<10	<10	<10	<10	NA	10
Sn	<5	<5	<5	<5	<5	<5	NA	5
Sr	1	<1	3	4	3	7	NA	1
Ta	<5	<5	<5	<5	<5	<5	NA	5
Te	<5	<5	<5	<5	<5	<5	NA	5
Ti	<0,01	<0,01	0,01	<0,01	<0,01	<0,01	NA	0,01



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